

## CLAIMS

What is claimed is:

1. 1. A method performed by a first computer node for selecting a leader node to provide  
2 service to a plurality of other nodes in a multicast group, wherein each of the nodes  
3 communicates using multicast, broadcast or anycast messages, the method comprising the  
4 computer-implemented steps of:

5 issuing a first election call message;  
6 receiving candidacy announcement messages from one or more leader candidate  
7 nodes in a specified time period;  
8 selecting a victor from among all leader candidate nodes from which candidacy  
9 announcement messages are received;  
10 receiving one or more victor announcement messages from one or more leader victor  
11 nodes for a second specified time period;  
12 resolving zero or more collisions among the victor announcement messages to result  
13 in selecting the leader node.

1. 2. A method as recited in Claim 1, wherein the leader node is a key server that provides  
2 keys for use in encrypting multicast group messages.

1. 3. A method as recited in Claim 1, wherein the leader node is a GDOI key server that  
2 provides keys to nodes according to Group Domain of Interpretation.

1. 4. A method as recited in Claim 1, further comprising:  
2 performing a coin toss operation that results in either a first result or a second result;  
3 and  
4 sending a candidacy announcement message in response to the first result occurring,  
5 or awaiting the candidacy announcement messages from the one or more  
6 leader candidate nodes in response to the second result occurring.

- 1    5. A method as recited in Claim 1, wherein the step of selecting a victor further  
2    comprises the steps of:
  - 3       determining whether the first computer node is the winner; and
  - 4       sending a victor announcement message in response to determining that the first  
5       computer node is the winner.
- 1    6. A method as recited in Claim 1, further comprising the step of ignoring any election  
2    call messages while awaiting receipt of the one or more candidacy announcement messages.
- 1    7. A method as recited in Claim 1, wherein selecting a victor comprises selecting one of  
2    the leader candidate nodes having a highest network address.
- 1    8. A method as recited in Claim 1, wherein resolving any collisions comprises:
  - 2       determining that two or more announcement messages have been received; and
  - 3       issuing a second election call message.
- 1    9. A method as recited in Claim 1, wherein the election call message, candidacy  
2    announcement messages, and victor announcement messages are multicast, broadcast or  
3    anycast messages.
- 1    10. A method as recited in Claim 1, further comprising the steps of:
  - 2       receiving, in the first election call message, first identity information specifying a  
3       second node that sent the first election call message;
  - 4       pushing the identity information onto a stack;
  - 5       receiving a second election call message that includes second identity information  
6       specifying a third node that sent the second election call message; and
  - 7       ignoring the second election call message when the second identity information is  
8       found in the stack.

1    11. A method as recited in Claim 1, wherein each of the messages comprises a packet  
2    type value, sender sequence number value, sender identity value, and a digital signature of a  
3    node that sent the message.

1    12. A method as recited in Claim 1, further comprising digitally signing each of the  
2    messages.

1    13. A method as recited in Claim 1, further comprising the steps of:  
2       creating a sequence number for each message that is sent;  
3       digitally signing each message before sending the message; and  
4       incrementing the sequence number.

1    14. A method as recited in Claim 1, wherein the step of issuing the first election call  
2    message is performed only after failing to receive a reply to a key server discovery message  
3    that is sent by the first node upon newly joining a multicast group.

1    15. A method as recited in Claim 1, wherein the first node is a member of an ad hoc  
2    multicast group.

1    16. A method performed by a first computer node for selecting a Group Domain of  
2    Interpretation (GDOI) key server to provide key service to a plurality of client nodes in a  
3    multicast group, the method comprising the computer-implemented steps of:  
4       issuing a first election call message;  
5       receiving candidacy announcement messages from one or more leader candidates in a  
6       specified time period;  
7       selecting a winner from among all leader candidates from which candidacy  
8       announcement messages are received;  
9       receiving one or more victor announcement messages from one or more leader victor  
10      nodes for a second specified time period;

11       resolving zero or more collisions among the victor announcement messages to result  
12       in selecting the leader node;  
13       wherein the election call message, candidacy announcement messages, and victor  
14       announcement messages are multicast, broadcast or anycast messages.

1       17. A method as recited in Claim 16, further comprising the steps of:  
2       receiving, in the first election call message, first identity information, specifying a  
3       second node that sent the first election call message;  
4       pushing the identity information onto a stack;  
5       receiving a second election call message that includes second identity information  
6       specifying a third node that sent the second election call message; and  
7       ignoring the second election call message when the second identity information is  
8       found in the stack.

1       18. A method as recited in Claim 16, wherein the step of issuing the first election call  
2       message is performed only after failing to receive a reply to a key server discovery message  
3       that is sent by the first node upon newly joining a multicast group.

1       19. A method as recited in Claim 16, further comprising:  
2       performing a coin toss operation that results in either a first result or a second result;  
3       and  
4       sending a candidacy announcement message in response to the first result occurring,  
5       or awaiting the candidacy announcement messages from the one or more  
6       leader candidates in response to the second result occurring.

1       20. A method as recited in Claim 16, wherein the step of selecting a winner further  
2       comprises the steps of:  
3       determining whether the first computer node is the winner; and  
4       sending a victor announcement message in response to determining that the first  
5       computer node is the winner.

1    21. A method as recited in Claim 16, further comprising the step of ignoring any election  
2    call messages while awaiting receipt of the one or more candidacy announcement messages.

1    22. A method as recited in Claim 16, wherein selecting a winner comprises selecting one  
2    of the leader candidates having a highest network address.

1    23. A method as recited in Claim 16, wherein resolving any collisions comprises:  
2       determining that two or more announcement messages have been received; and  
3       issuing a second election call message.

1    24. A method as recited in Claim 16, wherein each of the messages comprises a packet  
2       type value, sender sequence number value, sender identity value, and a digital signature of a  
3       node that sent the message.

1    25. A method as recited in Claim 1, further comprising the steps of:  
2       creating a sequence number for each message that is sent;  
3       digitally signing each message before sending the message; and  
4       incrementing the sequence number.

1    26. A method as recited in Claim 1, wherein the first node is a member of an ad hoc  
2       multicast group.

1    27. A computer-readable medium carrying one or more sequences of instructions for a  
2       first computer node for selecting a leader node to provide service to a plurality of other nodes  
3       in a multicast group, wherein each of the nodes communicates using multicast, broadcast or  
4       anycast messages, which instructions, when executed by one or more processors, cause the  
5       one or more processors to carry out the steps of:  
6       issuing a first election call message;

7 receiving candidacy announcement messages from one or more leader candidate  
8 nodes in a specified time period;  
9 selecting a victor from among all leader candidate nodes from which candidacy  
10 announcement messages are received;  
11 receiving one or more victor announcement messages from one or more leader victor  
12 nodes for a second specified time period;  
13 resolving zero or more collisions among the victor announcement messages to result  
14 in selecting the leader node.

1 28. A computer-readable medium as recited in Claim 27, wherein the leader node is a key  
2 server that provides keys for use in encrypting multicast group messages.

1 29. A computer-readable medium as recited in Claim 27, wherein the leader node is a  
2 GDOI key server that provides keys to nodes according to Group Domain of Interpretation.

1 30. A computer-readable medium as recited in Claim 27, further comprising instructions  
2 for:  
3 performing a coin toss operation that results in either a first result or a second result;  
4 and  
5 sending a candidacy announcement message in response to the first result occurring,  
6 or awaiting the candidacy announcement messages from the one or more  
7 leader candidate nodes in response to the second result occurring.

1 31. A computer-readable medium as recited in Claim 27, wherein the instructions for the  
2 step of selecting a victor further comprise instructions for the steps of:  
3 determining whether the first computer node is the winner; and  
4 sending a victor announcement message in response to determining that the first  
5 computer node is the winner.

1       32. A computer-readable medium as recited in Claim 27, further comprising instructions  
2       for the step of ignoring any election call messages while awaiting receipt of the one or more  
3       candidacy announcement messages.

1       33. A computer-readable medium as recited in Claim 27, wherein selecting a victor  
2       comprises selecting one of the leader candidate nodes having a highest network address.

1       34. A computer-readable medium as recited in Claim 27, wherein resolving any collisions  
2       comprises:

3              determining that two or more announcement messages have been received; and  
4              issuing a second election call message.

1       35. A computer-readable medium as recited in Claim 27, wherein the election call  
2       message, candidacy announcement messages, and victor announcement messages are  
3       multicast, broadcast or anycast messages.

1       36. A computer-readable medium as recited in Claim 27, further comprising instructions  
2       for the steps of:

3              receiving, in the first election call message, first identity information specifying a  
4              second node that sent the first election call message;

5              pushing the identity information onto a stack;

6              receiving a second election call message that includes second identity information  
7              specifying a third node that sent the second election call message; and

8              ignoring the second election call message when the second identity information is  
9              found in the stack.

1       37. A computer-readable medium as recited in Claim 27, wherein each of the messages  
2       comprises a packet type value, sender sequence number value, sender identity value, and a  
3       digital signature of a node that sent the message.

1    38. A computer-readable medium as recited in Claim 27, further comprising digitally  
2    signing each of the messages.

1    39. A computer-readable medium as recited in Claim 27, further comprising instructions  
2    for the steps of:  
3       creating a sequence number for each message that is sent;  
4       digitally signing each message before sending the message; and  
5       incrementing the sequence number.

1    40. A computer-readable medium as recited in Claim 27, wherein the step of issuing the  
2    first election call message is performed only after failing to receive a reply to a key server  
3    discovery message that is sent by the first node upon newly joining a multicast group.

1    41. A computer-readable medium as recited in Claim 27, wherein the first node is a  
2    member of an ad hoc multicast group.

1    42. An apparatus for a first computer node for selecting a leader node to provide service  
2    to a plurality of other nodes in a multicast group, wherein each of the nodes communicates  
3    using multicast, broadcast or anycast messages, comprising:  
4       means for issuing a first election call message;  
5       means for receiving candidacy announcement messages from one or more leader  
6       candidate nodes in a specified time period;  
7       means for selecting a victor from among all leader candidate nodes from which  
8       candidacy announcement messages are received;  
9       means for receiving one or more victor announcement messages from one or more  
10      leader victor nodes for a second specified time period;  
11      means for resolving zero or more collisions among the victor announcement  
12      messages to result in selecting the leader node.

1    43. An apparatus as recited in Claim 42, wherein the leader node is a key server that  
2    provides keys for use in encrypting multicast group messages.

1    44. An apparatus as recited in Claim 42, wherein the leader node is a GDOI key server  
2    that provides keys to nodes according to Group Domain of Interpretation.

1    45. An apparatus as recited in Claim 42, further comprising:  
2       means for performing a coin toss operation that results in either a first result or a  
3       second result; and  
4       means for sending a candidacy announcement message in response to the first result  
5       occurring, or awaiting the candidacy announcement messages from the one or  
6       more leader candidate nodes in response to the second result occurring.

1    46. An apparatus as recited in Claim 42, wherein the means for selecting a victor further  
2    comprises:  
3       means for determining whether the first computer node is the winner; and  
4       means for sending a victor announcement message in response to determining that the  
5       first computer node is the winner.

1    47. An apparatus as recited in Claim 42, further comprising means for ignoring any  
2    election call messages while awaiting receipt of the one or more candidacy announcement  
3    messages.

1    48. An apparatus as recited in Claim 42, wherein the means for selecting a victor  
2    comprises means for selecting one of the leader candidate nodes having a highest network  
3    address.

1    49. An apparatus as recited in Claim 42, wherein the means for resolving any collisions  
2    comprises:

3        means for determining that two or more announcement messages have been received;  
4              and  
5        means for issuing a second election call message.

1    50. An apparatus as recited in Claim 42, wherein the election call message, candidacy  
2    announcement messages, and victor announcement messages are multicast, broadcast or  
3    anycast messages.

1    51. An apparatus as recited in Claim 42, further comprising the steps of:  
2        means for receiving, in the first election call message, first identity information  
3            specifying a second node that sent the first election call message;  
4        means for pushing the identity information onto a stack;  
5        means for receiving a second election call message that includes second identity  
6            information specifying a third node that sent the second election call message;  
7            and  
8        means for ignoring the second election call message when the second identity  
9            information is found in the stack.

1    52. An apparatus as recited in Claim 42, wherein each of the messages comprises a  
2    packet type value, sender sequence number value, sender identity value, and a digital  
3    signature of a node that sent the message.

1    53. An apparatus as recited in Claim 42, further comprising means for digitally signing  
2    each of the messages.

1    54. An apparatus as recited in Claim 42, further comprising:  
2        means for creating a sequence number for each message that is sent;

3       means for digitally signing each message before sending the message; and  
4       means for incrementing the sequence number.

1   55. An apparatus as recited in Claim 42, further comprising means for issuing the first  
2   election call message only after failing to receive a reply to a key server discovery message  
3   that is sent by the first node upon newly joining a multicast group.

1   56. An apparatus as recited in Claim 42, wherein the first node is a member of an ad hoc  
2   multicast group.

1   57. An apparatus for a first computer node for selecting a leader node to provide service  
2   to a plurality of other nodes in a multicast group, wherein each of the nodes communicates  
3   using multicast, broadcast or anycast messages, comprising:  
4   a network interface that is coupled to the data network for receiving one or more packet  
5   flows therefrom;  
6   a processor;  
7   one or more stored sequences of instructions which, when executed by the processor, cause  
8   the processor to carry out the steps of:  
9     issuing a first election call message;  
10    receiving candidacy announcement messages from one or more leader candidate  
11    nodes in a specified time period;  
12    selecting a victor from among all leader candidate nodes from which candidacy  
13    announcement messages are received;  
14    receiving one or more victor announcement messages from one or more leader victor  
15    nodes for a second specified time period;  
16    resolving zero or more collisions among the victor announcement messages to result  
17    in selecting the leader node.

1   58. An apparatus as recited in Claim 57, wherein the leader node is a key server that  
2   provides keys for use in encrypting multicast group messages.

- 1    59. An apparatus as recited in Claim 57, wherein the leader node is a GDOI key server  
2    that provides keys to nodes according to Group Domain of Interpretation.
- 1    60. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2    instructions for:  
3       performing a coin toss operation that results in either a first result or a second result;  
4              and  
5       sending a candidacy announcement message in response to the first result occurring,  
6              or awaiting the candidacy announcement messages from the one or more  
7       leader candidate nodes in response to the second result occurring.
- 1    61. An apparatus as recited in Claim 57, wherein the step of selecting a victor further  
2    comprises the steps of:  
3       determining whether the first computer node is the winner; and  
4       sending a victor announcement message in response to determining that the first  
5       computer node is the winner.
- 1    62. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2    instructions for ignoring any election call messages while awaiting receipt of the one or more  
3    candidacy announcement messages.
- 1    63. An apparatus as recited in Claim 57, wherein selecting a victor comprises selecting  
2    one of the leader candidate nodes having a highest network address.
- 1    64. An apparatus as recited in Claim 57, wherein resolving any collisions comprises:  
2       determining that two or more announcement messages have been received; and  
3       issuing a second election call message.

1       65. An apparatus as recited in Claim 57, wherein the election call message, candidacy  
2 announcement messages, and victor announcement messages are multicast, broadcast or  
3 anycast messages.

1       66. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for:

3             receiving, in the first election call message, first identity information specifying a  
4             second node that sent the first election call message;  
5             pushing the identity information onto a stack;  
6             receiving a second election call message that includes second identity information  
7             specifying a third node that sent the second election call message; and  
8             ignoring the second election call message when the second identity information is  
9             found in the stack.

1       67. An apparatus as recited in Claim 57, wherein each of the messages comprises a  
2 packet type value, sender sequence number value, sender identity value, and a digital  
3 signature of a node that sent the message.

1       68. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for digitally signing each of the messages.

1       69. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for the steps of:  
3             creating a sequence number for each message that is sent;  
4             digitally signing each message before sending the message; and  
5             incrementing the sequence number.

1       70. An apparatus as recited in Claim 57, wherein the sequences of instructions for issuing  
2 the first election call message are performed only after failing to receive a reply to a key  
3 server discovery message that is sent by the first node upon newly joining a multicast group.

1       71. An apparatus as recited in Claim 57, wherein the first node is a member of an ad hoc  
2 multicast group.